

**METHOD AND APPARATUS FOR MEASURING THE SURFACE OF A GOLF
GREEN**

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional Patent Application Serial No. 60/448,456, entitled "Greens Speed Measuring Device" and filed February 21, 2003, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention pertains to devices measuring the surface or speed of golf greens. In particular, the present invention pertains to an apparatus for electronically sensing deceleration of a golf ball on a golf green and determining the speed of that green.

2. Discussion of the Related Art

Generally, the surface of a golf green is measured by golf course personnel to determine the speed of that green, where the speed values of golf greens may be utilized to provide consistency between the various greens of golf courses. This speed measurement relates to the distance a golf ball travels on the golf green in response to an initial velocity. The shorter the length of grass on the green, the farther a ball will travel for a given initial velocity, thereby yielding a higher measurement value or speed. Conversely, the longer the length of the grass, the shorter the distance traveled by the golf ball and the lower the measurement value or speed.

Currently, a STIMPMETER is utilized to measure the speed of a golf green. This device includes an extruded aluminum bar with a V-shaped groove defined therein extending along the entire length of the bar. One end of the bar is tapered and milled to enable placement of that end on the ground and to reduce bounce as a golf ball traverses the groove and makes contact with the green. A notch is disposed approximately thirty inches from the tapered end of the bar and provides a release point for the golf ball. The notch enables the

1 golf ball to be released and start to roll through the groove when the bar is raised to or
2 oriented at an angle of approximately twenty degrees relative to the ground. This ensures that
3 the velocity of the golf ball is consistent at the tapered end for each measurement.

4 In operation, a golf ball is placed in the notch and one end of the aluminum bar is
5 raised slowly until the ball rolls down the bar onto the grass surface of the golf green. The
6 distance the golf ball travels is measured by the operator, typically in units of feet, and
7 provided as the meter reading. For example, if the ball rolls eight feet, then the meter reading
8 or speed of the golf green is eight. The measurement or meter reading is typically conducted
9 for each of two opposite directions along the golf green and is based on the distances of travel
10 of three golf balls utilized for each direction.

11 The related art described above suffers from several disadvantages. In particular, the
12 above process to measure a golf green surface includes numerous manual procedures,
13 typically requiring at least two people and enduring for five minutes or more, thereby
14 increasing the time and effort to conduct a measurement. Further, the manual nature of the
15 process reduces the accuracy and consistency of the measurement and may provide
16 inconsistent readings or ones that do not correspond to the actual golf green conditions.
17 Moreover, the above process requires the golf green to be level in both directions in order to
18 conduct a measurement, thereby restricting the use of the process to particular greens of a golf
19 course.

20 OBJECTS AND SUMMARY OF THE INVENTION

21 Accordingly, it is an object of the present invention to measure the surface or speed of
22 a golf green in an efficient, consistent and accurate manner.

23 It is another object of the present invention to measure the surface or speed of a golf
24 green by electronically sensing and determining the deceleration of a golf ball along that
25 green.
26

27 Yet another object of the present invention is to reliably measure the surface or speed
28 of a golf green under various conditions (e.g., a substantially (but not perfectly) level surface,
29 along one direction of a golf green, varying grains of the golf green, etc.).

1 The aforesaid objects may be achieved individually and/or in combination, and it is
2 not intended that the present invention be construed as requiring two or more of the objects to
3 be combined unless expressly required by the claims attached hereto.

4 According to the present invention, a golf green measuring device includes a plurality
5 of substantially parallel rails that are spaced apart and attached to an enclosed structure. The
6 structure maintains separation of the rails and provides a mounting surface for a control unit
7 including a microcontroller or microprocessor, circuitry, a battery, a display and a level
8 indicator. One rail includes a pair of infrared (IR) light emitting diode (LED) emitters
9 disposed toward each of the front and rear ends of that rail, while the other rail includes
10 photo-transistor receivers or detectors each disposed in that rail coincident a corresponding
11 emitter. The infrared emitters and detectors sense a golf ball traveling through the enclosed
12 structure to enable the microcontroller to determine and display the speed of the golf green.
13 In particular, a golf ball is rolled between the rails, where the microcontroller measures the
14 elapsed time the golf ball travels between the pair of detectors disposed at the rail front end.
15 The microcontroller further records the elapsed time the golf ball travels between the pair of
16 detectors disposed at the rear end of the rail. The microcontroller determines the change in
17 velocity or deceleration of the golf ball based on the measured time intervals and converts that
18 deceleration into a speed value. The computed speed value is displayed on a device display.
19 The device may include an optional printer to provide a hardcopy of the measurement.

20 The present invention provides several advantages. In particular, the present invention
21 provides an efficient manner to measure the surface of a golf green, where a measurement
22 may be conducted by one person within seconds and may utilize a single trial of a golf ball
23 traversing the device in either direction. Further, the present invention provides an accurate
24 and consistent (or repeatable) measurement due to the inherent capabilities of electronic
25 processors or computers. Moreover, the present invention enables reliable measurements
26 under various conditions. For example, the device requires that the golf green be level in one
27 direction, where a level unit disposed on the device simplifies the process of proper
28 positioning. An accurate reading may be obtained as long as the slope of a golf green in the
29 direction opposite of the measurement does not cause the golf ball to contact the rails during
30 traversal of the device.

1 In addition, the present invention enables determination of the effects of the grain of
2 the grass at a specific location on the golf green without moving the device since a valid
3 reading may be obtained no matter which direction a golf ball traverses the device. For
4 example, once the device is positioned on the golf green, a golf ball may be directed through
5 the device in each of opposite directions, where the difference in the measurements indicates
6 the effect of the grain of the grass on that location.

7 The above and still further objects, features and advantages of the present invention
8 will become apparent upon consideration of the following detailed description of specific
9 embodiments thereof, particularly when taken in conjunction with the accompanying
10 drawings wherein like reference numerals in the various figures are utilized to designate like
11 components.

12 BRIEF DESCRIPTION OF THE DRAWINGS

13 Fig. 1 is a view in perspective of a device for measuring the surface of a golf green
14 according to the present invention.

15 Fig. 2 is a bottom view in elevation of the measuring device of Fig. 1.

16 Fig. 3A is a front view in elevation of a control unit of the measuring device of Fig. 1.

17 Fig. 3B is a front view in elevation of an alternative embodiment of the control unit of
18 Fig. 3A.

19 Fig. 4 is a schematic block diagram of exemplary control circuitry for the measuring
20 device of Fig. 1.

21 Fig. 5 is an exemplary electrical schematic diagram for the control circuitry of Fig. 4.
22

23 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

24 Generally, the surface of a golf green is measured to determine the speed of that green,
25 where the speed values of golf greens may be utilized to provide consistency between the
26 various greens of golf courses. This speed measurement is related to the distance a golf ball
27 travels on the golf green in response to an initial velocity. For example, if a golf ball rolls
28 eight feet, then the speed of the golf green is eight. The shorter the length of grass on the
29 green, the farther a golf ball will travel for a given initial velocity, thereby yielding a higher
30 speed value. Conversely, the longer the length of the grass, the shorter the distance traveled
31 by the golf ball and the lower the speed value. The speed value is typically determined in a

1 manual fashion by rolling golf balls across a golf green and measuring distances as described
2 above.

3 A device for electronically measuring the surface or speed of a golf green according to
4 the present invention is illustrated in Figs. 1 – 2. Specifically, device 10 includes a housing
5 11, a level unit 18 and a control unit 40. Housing 11 includes a pair of substantially parallel
6 rails or support bars 9, 12 and an upper housing section 14 supported by the rails. The rails
7 are each substantially rectangular and spaced apart, where the rails and supported upper
8 housing section form an enclosed passage 19 through device 10. By way of example only, the
9 rails each include a length or longer dimension of approximately thirty inches and are spaced
10 apart by a distance of approximately eight inches. Alternatively, the rails may be of any size
11 or shape and may be separated by any suitable distance. A pair of infrared (IR) emitters 22
12 (Fig. 2) are disposed toward each end of a rail 9. The emitters within each pair are disposed
13 on an interior surface of the rail within passage 19 and are preferably spaced apart along the
14 rail by approximately six inches. The emitters may alternatively be separated by any suitable
15 distance. Similarly, a pair of infrared (IR) detectors 24 are disposed toward each end of rail
16 12 with each detector 24 disposed on an interior surface of that rail within passage 19. The
17 detectors are each positioned substantially coincident a corresponding emitter 22 to detect the
18 signal or beam transmitted by that emitter. The emitters are preferably implemented by light
19 emitting diode (LED) type emitters, while detectors 24 are preferably in the form of photo-
20 transistor receivers. However, the emitters and detectors may be implemented by any
21 conventional or other emitters and/or detectors. The emitters and detectors sense a golf ball
22 traversing passage 19 to determine deceleration of that ball as described below. Since
23 sunlight or other ambient light may affect detectors 24, passage 19 is enclosed as described
24 above to prevent interference by ambient light.

25 Upper housing section 14 is attached to and supported by the top edges of rails 9, 12.
26 The upper housing section includes a generally trapezoidal cross section and encloses the area
27 below that section defined between rails 9, 12 to form passage 19. The upper housing section
28 includes top and bottom walls 16, 17 and side walls 15, 21, each substantially rectangular
29 with lengths or longer dimensions substantially similar to those of the rails. The top and
30 bottom walls are substantially parallel, where the width or shorter dimension of top wall 16 is
31 less than that of bottom wall 17. Side wall 15 is disposed between and attached to the upper

1 edge of rail 9 and lower edge of top wall 16, while side wall 21 is disposed between and
2 attached to the upper edge of rail 12 and lower edge of top wall 16. The side walls are angled
3 inward relative to the rails to accommodate the width differences between the top and bottom
4 walls and form the trapezoidal configuration. By way of example only, the device is
5 constructed of a suitably rigid plastic and includes a height of approximately eight inches, a
6 width of approximately ten inches and a length of approximately thirty inches; however, the
7 device may be of any size or shape and may be constructed of any suitable materials.

8 The top wall provides a mounting surface for receiving level unit 18 and control unit
9 40. The control unit is disposed toward a front end of the top wall with level unit 18 disposed
10 rearwardly of and adjacent the control unit. Level unit 18 is preferably implemented by a
11 conventional level device to indicate the slope of the golf green for identifying appropriate
12 locations to conduct a measurement as described below. Control unit 40 houses control
13 circuitry for device 10 and determines and displays the speed of an identified golf green based
14 on detection times of a golf ball traversing passage 19 as described below. A handle 20 is
15 further disposed on the top wall adjacent level unit 18 to facilitate transport of device 10. The
16 handle includes a substantially cylindrical bar 25 with a generally 'L'-shaped configuration.
17 The bar proximal end is attached to top wall 16, where the bar extends transversely therefrom
18 initially, and subsequently in a direction toward the device rear end substantially parallel to
19 the top wall. A grip 23 is disposed at the bar distal end with the handle 'L'-shaped
20 configuration providing sufficient distance between the grip and housing top wall to enable a
21 user to grasp the handle.

22 In order to conduct a measurement, a golf ball 27 is directed along the golf green and
23 through passage 19. This may be accomplished by a person putting (e.g., with a golf club) or
24 otherwise directing the golf ball through the passage. Alternatively, device 10 may be used in
25 combination with a launch 30 to direct golf ball 27 through the device passage. Specifically,
26 launch 30 includes a track member 32 and a stand 34. The track member includes side panels
27 31 and a generally rectangular platform 33. The platform includes a generally 'V-shaped' or
28 recessed configuration and is disposed between and attached to the upper edges of each side
29 wall to provide a path to direct or guide the golf ball. The track member includes an angled or
30 tapered distal end to form a complementary arrangement or interface with the ground or golf
31 green to enable a substantially smooth transition (e.g., minimal bounce) of golf ball 27 from

1 the track member to the ground or golf green.

2 The track member proximal end is raised or supported by stand 34 to an angle relative
3 to the ground or golf green sufficient to enable the golf ball to roll or traverse platform 33 and
4 attain a desired velocity. The stand includes legs 36 and a platform support 38. The platform
5 support includes a substantially cylindrical rod in a generally 'U'-shaped configuration. The
6 dimensions of the platform support are slightly greater than the width or shorter dimension of
7 the track member to receive a portion of the track member within the interior of the 'U'-
8 shaped configuration. Legs 36 each include a substantially cylindrical rod and are attached to
9 the underside of the platform support toward a respective opposing end portion. The legs
10 each extend from the platform support at a slight outward angle to enhance stability. The
11 stand typically engages the track member toward the track member proximal end. However,
12 the stand may engage the track member at any suitable location. The launch enables a golf
13 ball to attain a consistent initial velocity for each measurement.

14 Once a golf ball is directed through the device passage, control unit 40 determines and
15 displays the speed of the green based on detections of the golf ball by emitters 22 and
16 detectors 24. Referring to Fig. 3A, control unit 40 includes a housing 41, a display 42, a start
17 button 44 and a power switch 46. The display, start button and power switch are connected to
18 a control circuit 70 (Figs. 4 – 5) disposed in housing 41 and described below. Display 42 is
19 preferably implemented by a conventional liquid crystal display (LCD) and is disposed
20 toward the upper end of housing 41. The display may display speed values with a maximum
21 of three digits (e.g., including values with a decimal point). The display further includes
22 sensor and low power indicators 55, 57. The sensor indicators are preferably in the form of a
23 pair of dots or a colon to indicate detection of a golf ball by detectors 24. The sensor
24 indicators remain enabled until a subsequent measurement is taken (e.g., the start button is
25 depressed as described below). The power indicator is displayed in response to a device
26 power source or batteries 51 (Fig. 4) attaining a minimum level. The device power source is
27 preferably implemented by four double 'A' type batteries; however, any quantity of any type
28 of conventional or other power source may be utilized.

29 Start button 44 and power switch 46 are disposed adjacent each other toward a
30 housing lower end. Power switch 46 may be implemented by any type of toggle or other
31 switching device and enables power to device 10. The start button may be implemented by

1 any type of button or momentary switching device and prepares or resets device 10 to conduct
2 a measurement. Basically, the control circuit receives a signal from each detector 24 during
3 traversal of the golf ball through device passage 19. The control circuit determines the speed
4 of the golf green based on elapsed time between these signals as described below and displays
5 the resulting speed value on display 42. Once the detector signals are received, emitters 22
6 are disabled, while display 42 displays the resulting speed value until the start button is
7 depressed indicating a new measurement is to be conducted.

8 Control unit 40 may employ various displays, buttons, indicators and/or switches. An
9 exemplary alternative control unit is illustrated in Fig. 3B. Specifically, the control unit
10 includes an LED display 43, start button 44, display value or re-read button 45, a power
11 button 47 and a series of indicators or LEDs 49. Display 43 is preferably implemented by a
12 conventional light emitting diode (LED) type display and is disposed toward the upper end of
13 control unit housing 41. The display may display speed values with a maximum of three
14 digits (e.g., including values with a decimal point). Start button 44, power button 45 and
15 display value button 47 are disposed adjacent each other below display 43 and may be
16 implemented by any type of button or momentary switching device. The power button
17 enables power to the control unit, while the start button prepares or resets the device to
18 conduct a measurement. Since an LED display typically has greater power consumption than
19 an LCD display, a nine volt type battery is preferably employed to power the control unit.
20 Further, the control unit and LED display may each power down after respective
21 predetermined time intervals (e.g., five minutes for the control unit and five seconds for the
22 display) to conserve power. In this case, the control unit maintains the measurement after the
23 display power down and during the remainder of the control unit predetermined time interval,
24 where the measurement may be displayed by depressing display value button 47. In addition,
25 power button 45 may be depressed after expiration of the control unit predetermined time
26 interval to conduct a new measurement. Indicators 49 are preferably implemented by light
27 emitting diodes (LEDs) and are each associated with a corresponding detector 24. The
28 indicators are disposed between the display and buttons 44, 45, 47 and indicate the proper
29 operation of detectors 24, where the indicators are initially illuminated and subsequently
30 individually disabled in response to a corresponding detector sensing the golf ball. Thus, the
31 successive disablement of the indicators serves to display the progress of the golf ball through

1 the device passage.

2 An exemplary control circuit for control unit 40 (Fig. 3A) is illustrated in Fig. 4. It is
3 to be understood that the exemplary control circuit may be modified to accommodate control
4 units with various displays, buttons, switches and indicators (e.g., Fig. 3B, etc.). Specifically,
5 control circuit 70 includes a microcontroller or processor 50 and display 42. A power source
6 51 provides power to the control circuit and is preferably implemented by four double 'A'
7 type batteries. The microcontroller or processor controls device 10 and is preferably
8 implemented by an eight bit microcontroller. By way of example only, the microcontroller
9 may be implemented by the Motorola HC705KJI microcontroller including ten bidirectional
10 ports and operating at four megahertz (MHz). Display 42 is preferably implemented by a three
11 digit, seven segment liquid crystal (LCD) type display unit and includes a sensor indicator and
12 a low battery indicator as described above. The display is coupled to a wave driver source 68
13 that generates a low frequency square wave (e.g., thirty-two Hertz) to drive the display. The
14 display is further coupled to a least significant digit driver 54, an intermediate digit driver 58,
15 a most significant digit driver 60, a decimal point driver 62, a sensor indicator driver 64 and a
16 low battery driver 66. These drivers control corresponding digits and indicators of display 42
17 to display the measured speed value of a golf green and corresponding device conditions as
18 described below. The intermediate and most significant digit drivers are further coupled to a
19 control driver 56 that controls display of these digits. The digit drivers are each associated
20 with a corresponding digit having a particular location within the display, where the quantities
21 represented by the digits depend on placement of a decimal point. By way of example only
22 and with respect to the speed value shown in Fig. 3A, least significant digit driver 54 controls
23 the display digit representing tenths, intermediate digit driver 58 controls the display digit
24 representing ones or units, and most significant digit driver 60 controls the display digit
25 representing tens. However, the digits controlled by these drivers may represent any
26 quantities (e.g., tenths, hundredths, ones, tens, hundreds, etc.).

27 Microcontroller 50 is coupled to emitters 22, start button 44, a power monitor 48 and
28 various drivers (e.g., least significant digit driver 54, control driver 56, intermediate digit
29 driver 58, most significant digit driver 60, low battery driver 66, etc.). The start button resets
30 the control unit in preparation for a measurement as described above. The power monitor is
31 coupled to power switch 46 that controls power to the control circuit. The power monitor

1 ensures appropriate power levels at start-up prior to enabling reset of the microcontroller.
2 Infrared detectors 24 are further coupled to the microcontroller via a logic module 53. The
3 logic module provides signals to the microcontroller indicating traversal of a detector by the
4 golf ball to enable the microcontroller to determine golf ball deceleration and a speed value
5 for a golf green as described below. The microcontroller is further coupled to a counter 52
6 that controls the least significant digit and control drivers 54, 56 to display the speed value
7 based on the measurement.

8 An exemplary electrical schematic of the control circuit of Fig. 4 is illustrated in Fig.
9 5. Specifically, power is supplied from power source 51 to power monitor 48 in response to
10 actuation of power switch 46. The power monitor includes a zener diode 72 and a reset
11 device 76. The zener diode (and an accompanying capacitor 74 arranged in a parallel relation)
12 maintains a supplied voltage level (e.g., V_{CC}) within the operating limits of microcontroller
13 50. Reset device 76 maintains the reset line of microcontroller 50 at a low level until power is
14 stabilized. The reset device basically provides a ground to the microcontroller reset line for a
15 predetermined time interval (e.g., 350 milliseconds).

16 Once reset of the microcontroller is complete, a high level signal is produced at a
17 microcontroller output (e.g., PB3 as viewed in Fig. 5). This signal enables a transistor 78 to
18 apply power to infrared (IR) emitters 22 disposed within the device passage. The
19 microcontroller reset further produces zeros on display 42. During transmission by IR emitters
20 22, corresponding detectors or photo-transistors 24 detect the transmitted energy and produce
21 high level signals. These signals typically appear on pins (e.g., pins two, three, four and five
22 as viewed in Fig. 5) of a connector (not shown) connecting detectors 24 to control circuit 70.
23 The detector high level signals are provided to logic module 53. The logic module includes a
24 series of inverters 80, each associated with a corresponding detector, and a logic unit 82
25 coupled to the inverters. The high level detector signals are inverted by corresponding
26 inverters 80, thereby producing low level output signals at the inputs of logic unit 82. The
27 logic unit preferably includes NOR type logic and produces a resulting high level output
28 signal in response to low level input signals. The logic unit output is coupled to the
29 microcontroller interrupt request line (e.g., IRQ as viewed in Fig. 5), where a low level signal
30 triggers a microcontroller interrupt. Thus, a microcontroller interrupt is not generated by the
31 logic unit as long as each detector senses the transmitted beam from a corresponding emitter.

1 However, when a golf ball traverses the device passage, the golf ball passes each
2 detector and blocks or prevents detection by that detector of the beam transmitted by the
3 corresponding emitter. The detector produces a low level signal in response to the golf ball
4 blocking the transmitted beam that is inverted by an associated inverter 80. The resulting
5 inverted or high level signal is provided at the input of logic unit 82. The NOR type logic of
6 the logic unit produces a low level signal that triggers a microcontroller interrupt. In
7 particular, when a golf ball is directed through the device passage, the golf ball prevents
8 detection by or breaks the transmitted beam of an initial detector 24 (e.g., disables the detector
9 or photo-transistor) located toward the passage front end. The associated inverter receives a
10 low level signal and produces a high level signal at the corresponding input of logic unit 82.
11 The NOR type logic of the logic unit produces a low level output signal on the
12 microcontroller interrupt request line (e.g., IRQ as viewed in Fig. 5), thereby generating a
13 microcontroller interrupt that initiates a timing measurement.

14 As the golf ball traverses the next detector in the device passage, that detector or
15 photo-transistor is disabled and the associated inverter produces a high level signal at the
16 input of logic unit 82 as described above. The logic unit produces a low level output signal on
17 the microcontroller interrupt request line that generates an interrupt indicating the end of the
18 timing interval. The timing measurement is recorded by the microcontroller. The golf ball
19 continues through the device passage and disables the next detector or phototransistor
20 disposed toward the passage rear end. The associated inverter produces a high level signal at
21 the input of logic unit 82 as described above. The logic unit produces a low level output
22 signal on the microcontroller interrupt request line that initiates another timing measurement.
23 When the ball traverses the remaining passage detector 24, that detector or photo-transistor is
24 disabled and the associated inverter produces a high level signal at the input of logic unit 82
25 as described above. The logic unit produces a low level output signal on the microcontroller
26 interrupt request line that generates an interrupt indicating the end of the timing interval. The
27 timing measurement is recorded by the microcontroller. The timing measurements may be
28 further processed as described below, where the ratio of the measurements indicates golf ball
29 deceleration. Since the microcontroller is triggered by interrupt request signals, a valid
30 measurement may be achieved by the golf ball traversing the device passage in either
31 direction (e.g., front to rear or rear to front). This greatly facilitates measuring the effects of

1 the grain of the grass on the golf green, where the effects may be measured without
2 positioning the device at a new location or in a different orientation.

3 Once an interrupt request associated with each detector has been received, the
4 microcontroller produces a low level signal at a microcontroller output (e.g., PB3 as viewed in
5 Fig. 5), thereby disabling transistor 78 and power to emitters 22 in order to conserve power
6 source 51. The recorded time measurement between the first interrupt requests or between the
7 first pair of detectors 24 traversed by the golf ball indicates initial velocity of the golf ball.
8 The recorded time measurement between the second pair of detectors 24 traversed by the golf
9 ball indicates the terminal velocity of the golf ball. An index is calculated from these values
10 by the microcontroller and translated into a speed value for the golf green. In particular, the
11 microcontroller determines an index based on the ratio of elapsed times between the final and
12 initial pairs of detectors 24. In other words, the elapsed time between the final pair of
13 detectors (e.g., indicating the terminal velocity of the golf ball) is divided by the elapsed time
14 between the initial pair of detectors (e.g., indicating the initial velocity of the golf ball). The
15 index is utilized to retrieve a speed value from a table stored in the microcontroller or other
16 memory including speed values for various indices (e.g., golf ball velocity ratios) that were
17 determined experimentally by conventional techniques (e.g., STIMPMETER, etc.).
18 Alternatively, the microcontroller may record time stamps corresponding to the time a
19 detector senses the golf ball and determine the speed value (e.g. distance the golf ball will
20 travel) based on measured and other parameters (e.g., initial and terminal elapsed times and/or
21 golf ball velocities, distances between detectors, etc.).

22 Once the speed value is determined, the speed value is displayed on display 42. In
23 particular, pulses are created on a microcontroller output (e.g, PA4 as viewed in Fig. 5) and
24 applied to counter 52. The quantity of pulses produced by the microcontroller corresponds to
25 the quantity represented by the digits of the speed value (e.g., with placement of the decimal
26 point after the least significant digit), where counter 52 is associated with the least significant
27 digit of the speed value. For example, the microcontroller produces one hundred five pulses
28 for speed values of 10.5, 1.05 or .105. The counter is incremented in response to each pulse
29 received from the microcontroller and maintains a count between zero and nine. The count or
30 output of the counter is coupled to least significant digit driver 54 (e.g., latch/decoder, etc.)
31 that controls the least significant digit of the display. This driver is basically a binary coded

1 decimal (BCD) to seven segment driver/decoder that receives the counter output and produces
2 signals to display the count value on display 42 (e.g., the signals enable the appropriate
3 display segments to display the count value). When counter 52 reaches a value of nine, the
4 next pulse resets the counter and produces a pulse on an input of control driver 56 (e.g., 2E as
5 viewed in Fig. 5) associated with counters for the intermediate and most significant digits.

6 The control driver is implemented by a counter that maintains counts for the
7 intermediate and most significant digits of the display. Counter outputs associated with the
8 intermediate digit count are coupled to intermediate digit driver 58, while counter outputs for
9 the most significant digit count are coupled to most significant digit driver 60. The control
10 driver maintains counts between zero and nine for the intermediate and most significant digits,
11 where the intermediate digit count is incremented for every ten pulses of counter 52, and the
12 most significant digit count is incremented for every ten counts or increments of the
13 intermediate digit count. Basically, when the count or quantity of pulses on the control driver
14 input for the intermediate digit counter reaches a value of nine, the next pulse resets the
15 intermediate digit count and produces a pulse on the control driver input (e.g., 1E as viewed in
16 Fig. 5) to increment the most significant digit count. The intermediate and most significant
17 digit drivers are each implemented by a respective binary coded decimal (BCD) to seven
18 segment driver/decoder. Each driver receives the corresponding counter output (e.g.,
19 intermediate and most significant digit counts) and produces signals to display that count
20 value on display 42 (e.g., the signals enable the appropriate display segments to display the
21 count value).

22 During the counting process described above, a high level blanking signal is
23 transmitted on a microcontroller output (e.g., PA3 as viewed in Fig. 5) that is coupled to the
24 least significant, intermediate and most significant digit drivers. This signal disables the
25 drivers to prevent display of the various digits until the pulses from the microcontroller have
26 been counted. After the pulses have been transmitted by the microcontroller, the high level
27 blanking signal is removed from the microcontroller output (e.g., PA3 as viewed in Fig. 5)
28 and the drivers are enabled to display the various counts representing the speed value digits on
29 display 42. When start button 44 is actuated or depressed, a reset occurs that prepares device
30 10 for a measurement. The start button further resets counters 52, 56 to initialize the display
31 (e.g., to display zeros) and enables infrared (IR) emitters 22.

1 Decimal point driver 62, sensor indicator driver 64 and low battery driver 66 are
2 preferably implemented by dual input AND type logic devices with one input coupled to
3 wave driver source 68. The decimal point driver generally controls display of the decimal
4 point. Sensor indicator driver 64 controls display of two dots or a colon to indicate that
5 detectors 24 are functioning properly. When a reset is initiated (e.g., start button 44 is
6 actuated or depressed), the sensor indicator is initially removed, where the indicator blinks or
7 flashes in response to a golf ball traversing a detector 24 (e.g., the golf ball interrupts or
8 blocks detector 24 from detecting a beam transmitted by a corresponding emitter 22). The
9 sensor indicator driver is further coupled to the microcontroller interrupt request line (e.g.,
10 IRQ as viewed in Fig. 5) to determine traversal of a detector by the golf ball (e.g., an interrupt
11 is generated when a golf ball traverses a detector as described above). After four interruptions
12 (e.g., the golf ball has traversed the device passage), the interrupt request line of the
13 microcontroller enters and maintains a low level state until start button 44 is actuated or
14 depressed, thereby preventing display of the sensor indicator between measurements.

15 The low battery indicator is controlled by low battery driver 66. The microcontroller
16 basically monitors a voltage divider circuit (e.g., including a resistor 83 arranged in series
17 with a parallel arrangement of a resistor 84 and a capacitor 86 as viewed in Fig. 5) coupled to
18 power source 51. When the microcontroller senses a low level signal on a microcontroller
19 input (e.g., PB2 as viewed in Fig. 5) relative to a threshold, the microcontroller transmits a
20 high level signal on a microcontroller output (e.g., PA7 as viewed in Fig. 5) that enables low
21 battery driver 66 to display the low battery indicator. The control circuit components may be
22 implemented by any conventional or other devices and may be arranged in any fashion. The
23 component characteristics (e.g., resistance, capacitance, etc.) illustrated in Fig. 5 are
24 exemplary, where the circuit components may include any desired characteristic values.

25 Operation of device 10 is described with reference to Figs. 1 and 4. Initially, a golf
26 green location that is level in at least one direction is identified to perform a measurement.
27 This identification may be performed by placing device 10 at the desired golf green location
28 and observing the indication of level unit 18. Once the desired location is identified, golf ball
29 27 is directed through the device passage. This may be accomplished by putting or otherwise
30 directing the golf ball through the passage. Alternatively, the golf ball may be directed
31 through the device passage via launch 30. In this case, the golf ball is placed on the launch

1 track member, where the golf ball rolls along the track member and into and through the
2 device passage as described above.

3 As the golf ball traverses an initial pair of detectors 24 within the device passage,
4 microcontroller 50 measures and records the elapsed travel time of the golf ball between the
5 two detectors. The microcontroller similarly measures and records the elapsed travel time of
6 the golf ball between the terminal pair of detectors and determines the index (e.g., change or
7 ratio of initial and terminal velocities) as described above. The index is utilized to retrieve a
8 corresponding speed value from a table stored within the microcontroller or other memory.
9 Alternatively, the microcontroller may determine the speed value based on the measured and
10 other parameters. The resulting speed value is displayed on display 42. Device 10 may
11 further include or be coupled to a printer to provide a report or hardcopy of the measured
12 speed or other values. Further, the device may measure the speed of a golf green with a single
13 pass of a golf ball, while the golf ball may traverse the device passage in either direction to
14 obtain a speed measurement. Thus, the device may measure the effects of the grain of the
15 grass on the golf green (e.g., by comparing the measured speed value for each direction)
16 without having to re-position the device.

17 It will be appreciated that the embodiments described above and illustrated in the
18 drawings represent only a few of the many ways of implementing a method and apparatus for
19 measuring the surface of a golf green.

20 The device may be of any shape or size and may be constructed of any suitable
21 materials. The device housing may be of any shape or size and may be constructed of any
22 suitable materials. The rails may be of any quantity, shape or size and may be constructed of
23 any suitable materials. The rails may be spaced apart by any suitable distance and may be
24 arranged in any relation relative to each other (e.g., substantially parallel, converging or
25 diverging, etc.). Each of the rails may include any quantity of any type of emitter and/or
26 detector secured thereto or embedded therein in any fashion (e.g., brackets, adhesives, formed
27 integral, etc.) or arrangements and at any locations.

28 The housing upper section may be of any shape or size and may be constructed of any
29 suitable materials. The upper housing walls (e.g., top, bottom, side, etc.) may be of any shape
30 or size and arranged in any fashion (e.g., the walls may be oriented at any desired angles
31 relative to each other, etc.) for any cross-sectional configuration. The upper section may be

1 permanently or removably attached to the rails via any conventional or other techniques (e.g.,
2 welding, brackets, etc.). The handle may be of any quantity, may be disposed at any location,
3 may be implemented by any conventional or other handle and may include any type of
4 configuration (e.g., 'L'-shape, 'C'-shape, etc.). The handle bar may be of any shape or size
5 and include any conventional or other grip disposed at any suitable location.

6 The ball may be directed through the device passage in any desired manner (e.g.,
7 putted via a golf club, launch, mechanism or device to project the ball, etc.). The resulting
8 speed value may be based on any quantity of measurements of golf balls or other objects
9 directed through the device for any quantity of directions, where the measurements may be
10 combined in any fashion (e.g., averaged, weighted, summed, etc.) by the operator and/or
11 microcontroller to produce the resulting speed value. The launch may be of any shape or size
12 and may be constructed of any suitable materials. The track member and associated
13 components (e.g., side panels, platform, etc.) may be of any shape or size and may be
14 constructed of any suitable materials. The platform may include any configuration suitable to
15 maintain and guide the ball (e.g., recessed, 'V' shaped, curved , etc.). The stand and
16 associated components (e.g., platform support, legs, etc.) may be of any shape or size and may
17 be constructed of any suitable materials. The platform support may be of any quantity and
18 include any suitable configuration to engage and support the track member (e.g., 'U'-shaped,
19 etc.). The legs may be of any quantity and may be attached or secured to the platform support
20 in any fashion (e.g., welded, brackets, etc.) and at any desired locations. The legs may
21 alternatively be directly attached to the track member without the platform support. The
22 launch may be configured to orient the track member at any desired angle relative to the
23 ground to enable the ball to attain any desired velocity. The launch may be disposed at any
24 desired distance from the measuring device to direct the ball through that device.

25 The device passage may be of any shape or size, and may include any type of path for
26 the ball (e.g., linear, curved, etc.). The passage may include any quantity of emitters and/or
27 detectors disposed at any suitable locations and arranged in any desired fashion (e.g., spaced
28 by any desired distances, etc.). The passage may alternatively include any sensing or
29 detecting devices (e.g., pressure sensors or switches, buttons, switching devices, etc.) to detect
30 traversal of the golf ball or other object through the passage. The passage is preferably
31 enclosed to prevent interference from ambient light, but may be open or include any desired

1 degree of transparency (e.g., transparent, translucent, opaque, etc.). The emitters may be
2 implemented by any quantity of any conventional or other emitters (e.g., LED emitters, etc.)
3 transmitting any desired energy (e.g., infrared, light, laser, ultrasonic, etc.). Similarly, the
4 detectors may be implemented by any quantity of any conventional or other detectors (e.g.,
5 photo-transistors, etc.) detecting any desired energy (e.g., infrared, light, laser, ultrasonic,
6 etc.). The emitters and detectors may be arranged in any fashion and may each be separated
7 from adjacent or corresponding emitters and/or detectors by any suitable distances.

8 The level unit may be implemented by any quantity of any conventional or other level
9 device and may be disposed at any suitable location on the measuring device. The control
10 unit may be of any shape or size and may be constructed of any suitable materials. The
11 control unit may be disposed at any suitable location on the measuring device. The control
12 unit housing may be of any shape or size and may be constructed of any suitable materials.
13 The display may be implemented by any quantity of any conventional or other displays (e.g.,
14 LED, LCD, etc.) and may display any desired quantity of digits or indicators. The display
15 may be disposed at any suitable location on or within the control unit and may display any
16 desired information. The control unit may include any quantity of any conventional or other
17 buttons, switching devices or indicators (e.g., momentary switch, pole switch, toggle switch,
18 LEDs, audio indicator, visual indicator, etc.) to control functions (e.g., start button, power
19 button or switch, display button, etc.) or indicate conditions. The buttons, switches and/or
20 indicators may be disposed at any suitable locations on or within the control unit. The control
21 unit and/or display may be powered down after expiration of any desired time interval to
22 conserve power.

23 The control circuit may be implemented by any quantity of any conventional or other
24 components (e.g., diodes, transistors, resistors, capacitors, processors, counters, logic, gates,
25 etc.) arranged in any fashion to perform the functions described herein. The circuit
26 components may be arranged in any fashion and may include any desired characteristic values
27 (e.g., resistance, capacitance, etc.). The power source may be implemented by or receive
28 power from any quantity of any conventional or other power source (e.g., vehicle electrical
29 system, generator, wall outlet, rechargeable battery, consumer batteries (e.g., 'AA', 9V, etc.),
30 etc.). The power monitor may include any quantity of conventional or other components
31 (e.g., diodes, capacitors, resistors, etc.) to maintain the input voltage and delay reset of the

1 microcontroller. The reset device may be implemented by any quantity of conventional or
2 other components and may apply ground to the reset line for any desired time interval.

3 The microcontroller may be implemented by any quantity of any conventional or other
4 processor. The counters may be implemented by any conventional or other counting devices
5 (e.g., counters, ALU, logic, etc.). The microcontroller may generate any quantity of pulses in
6 response to a speed value to control the drivers to display that value. The wave driver source
7 may be implemented by any conventional or other components or signal generators to
8 produce the signal to drive the display. The display driving signal may be of any desired
9 frequency. The digit drivers may be associated with any display digit and may be in the form
10 of any conventional or other driving or decoding device to produce signals from any type of
11 input to display a desired value (e.g., BCD decoder, etc.). For example, the microcontroller
12 may output the value of each speed value digit directly to the corresponding driver (e.g.,
13 without employing the pulses or counters) to enable display of that value. Alternatively, the
14 microcontroller may output display control signals to control the display (e.g., decode the
15 speed value digits internally for output to the display, etc.) to enable display of that value
16 and/or the indicators. The display digits may be associated with any quantity of units in
17 accordance with placement of the decimal point (e.g., ones, tens, hundreds, tenths,
18 hundredths, etc.). The speed value may be processed in any desired fashion by any control
19 circuit or other devices (e.g., microcontroller, drivers, counters, etc.) to produce appropriate
20 display control signals to enable display of that value. The logic module may include any
21 quantity of any type of logic device (e.g., AND, OR, NAND, NOR, gates, circuitry, etc.) and
22 may accommodate data or signals in inverted or non-inverted form (e.g., with or without the
23 inverters). The inverters may be implemented by any quantity of conventional or other
24 inverting devices (e.g., gates, transistors, etc.).

25 The sensor and low battery indicators may be of any quantity and in the form of any
26 desired symbol or alphanumeric, punctuation or other characters and may be shown on the
27 display at any desired locations and in any fashion. The decimal point may be displayed on
28 the display at any desired location and in any fashion. The drivers for the decimal point and
29 indicators may include any quantity of any conventional or other logic (e.g., AND, OR,
30 NAND, NOR, gates, circuitry, etc.) or control devices (e.g., circuitry, processor, etc.) to
31 control their display. The low battery detector may be implemented by any conventional or

1 other devices or circuitry (e.g., meter, voltage divider circuit, etc.). A low battery or power
2 indication may be indicated based on any desired threshold.

3 The table may include any quantity of speed values arranged or accessible in any
4 fashion. The table may be implemented by any quantity of any type of data structure or
5 storage device (e.g., array, table, list, queue, stack, buffer, etc.). The table may be stored in
6 the microcontroller memory or any type of memory or storage device accessible to the
7 microcontroller locally or remotely. The speed values in the table may be accessed based on
8 any desired indices, keys or values. The microcontroller may determine the table key based
9 on any mathematical or other operations applied to measured or known parameters.
10 Alternatively, the microcontroller may determine the speed value or distance of travel of the
11 golf ball or other object based on the measured or known parameters (e.g., time or velocity,
12 distances, etc.).

13 It is to be understood that software for the microcontroller may be implemented in any
14 desired computer language, and could be developed by one of ordinary skill in the computer
15 and/or programming arts based on the functional description contained herein. Further, any
16 references herein of software performing various functions generally refer to computer
17 systems or processors performing those functions under software control. The
18 microcontroller may alternatively be implemented by hardware or other processing circuitry.
19 The various functions of the microcontroller and/or control circuit may be distributed in any
20 manner among any quantity (e.g., one or more) of hardware and/or software modules or units,
21 computer or processing systems or circuitry, where the computer or processing systems may
22 be disposed locally or remotely of each other and communicate via any suitable
23 communications medium. The algorithms and/or control circuit described above may be
24 modified in any manner that accomplishes the functions described herein.

25 The measuring device may be linked via any communication medium to a local or
26 remote processor (e.g., computer, etc.) or printing device to provide measurements to local or
27 remote users. The printing device may alternatively be housed within the measuring device to
28 provide a hardcopy of the measurement and any other desired information (e.g., measured
29 parameters, etc.).

1 It is to be understood that the terms “top”, “bottom”, “front”, “rear”, “side”, “height”,
2 “length”, “width”, “upper”, “lower” and the like are used herein merely to describe points of
3 reference and do not limit the present invention to any particular orientation or configuration.

4 The measuring device of the present invention is not limited to the applications
5 described above, but may be utilized to measure various surfaces (e.g., baseball
6 infield/outfield, polo grounds, croquet fields, football fields, tennis courts, pool tables, etc.)
7 upon which activities may be conducted. Further, the measuring device may determine
8 deceleration of various objects (e.g., baseball, polo ball, croquet ball, tennis ball, etc.) directed
9 through the device (which may or may not pertain to the particular activity for the surface) to
10 produce a measurement. For example, a golf ball may be utilized to measure a baseball field,
11 polo ground or other surface. In addition, the measuring device may be adapted to convert the
12 measured parameters or elapsed time into any desired scale (e.g., pertaining to an activity,
13 etc.).

14 From the foregoing description, it will be appreciated that the invention makes
15 available a novel method and apparatus for measuring the surface of a golf green, wherein a
16 device electronically measures deceleration of a golf ball on the green and determines the
17 speed of that green based on the measurements.

18 Having described preferred embodiments of a new and improved method and
19 apparatus for measuring the surface of a golf green, it is believed that other modifications,
20 variations and changes will be suggested to those skilled in the art in view of the teachings set
21 forth herein. It is therefore to be understood that all such variations, modifications and
22 changes are believed to fall within the scope of the present invention as defined by the
23 appended claims.